

Cyanobacteria and their Toxins

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SCIENCE QUESTION

Harmful algal blooms (HABs) of cyanobacteria, also known as blue-green algae, are increasing in spatial and temporal prevalence in the US and worldwide. Cyanobacterial HABs are occurring in all types of water bodies, and their highly potent toxins are a significant hazard for human health and ecosystem viability. Currently, the US has no guidelines or regulations on cyanobacteria or cyanotoxins.

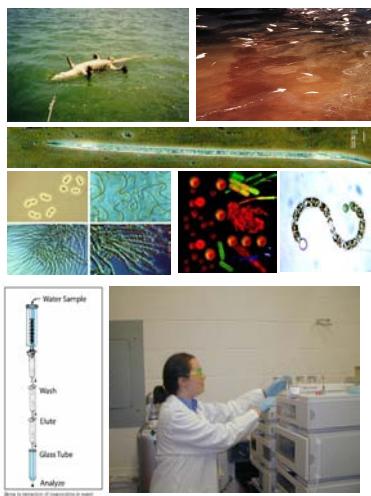
Cyanobacteria and their toxins are a concern for US EPA's Office of Water (OW); they are on OW's Unregulated Contaminant Monitoring Regulation List 3 (UCMR), and the Contaminant Candidate List. OW is unable to make regulatory determinations at this time due to the lack of methods and data. Additionally, the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA) mandates interagency products on cyanobacteria, including the development of a National Research Program on cyanobacteria. To help meet the needs of the OW and the mandates of HABHRCA, ORD is leading the organization of an Interagency, International Symposium on Cyanobacterial HABs (IISOC).

RESEARCH GOALS

- Identify and prioritize research needed to support risk assessments, regulatory determinations and guideline development
- Characterize cyanotoxin properties
- Develop analytical methods
- Collect occurrence data
- Assess health and ecosystem effects
- Identify causes of cyanobacterial HABs
- Strategize prevention, control and mitigation

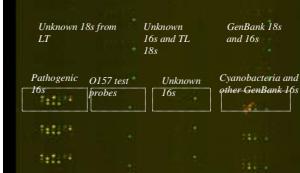
METHODS/APPROACH

- IISOC organization – 6 session topics with 26 subtopics addressed through 26 platform sessions and 6 workgroups, each with specific charges
- Conduct an epidemiologic study on the health effects of repeated, low-level exposure to cyanotoxins in drinking water
- Assess behavioral and developmental effects of cyanotoxins
- Investigate technologies to inactivate and/or destroy cyanotoxins in water
- Characterize relationships between nutrient loading and other causes of cyanobacterial HABs



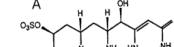
NERL scientists are refining analytical methods to monitor cyanotoxins needed for a UCMR study.

NCER Support for Cyanobacteria Research: four STAR Grants, two Fellowships, and two Small Business Initiatives – Example: Microarray Detection of Cyanobacterial Genes, Park Rublee, UNC-Greensboro – STAR Grant R831627



A microarray test is currently being developed for cyanobacteria and cyanotoxin genes in drinking water reservoirs as an aid to risk assessment and management of water supplies.

Cylindrospermopsin toxin



Chemical structure of Cylindrospermopsin toxin.



Chemical structure of Anatoxin-a toxin.

Anatoxin-a toxin

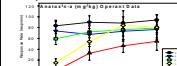
For performance, rats develop tolerance to both anatoxin-a and nicotine.

For motor activity, rats do not develop tolerance or sensitivity to anatoxin-a as they do with nicotine.

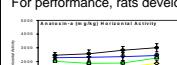
Therefore, the behavioral effects of anatoxin-a and nicotine are not identical, which indicates differences in the toxicodynamics of the two compounds.

Behavioral Effects of Anatoxin-a and Nicotine

Cyanotoxin anatoxin-a is a nicotinic cholinergic agonist. We therefore compared the behavioral effects of anatoxin-a and nicotine given i.v.



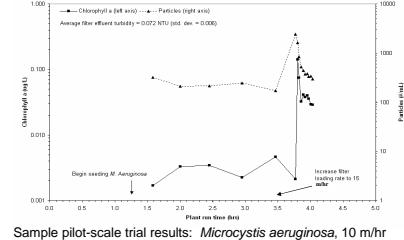
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Drinking Water Filter Breakthrough



Sample pilot-scale trial results: *Microcystis aeruginosa*, 10 m³/h initial filter loading rate, ferric chloride + cationic polymer coagulant.

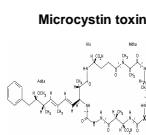
IMPACTS/OUTCOMES

The ORD-led Interagency, International Symposium on Cyanobacterial Harmful Algal Blooms will be held on September 6-10, 2005 in Research Triangle Park, NC. The products of IISOC will:

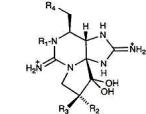
- Identify components of a National Research program on Cyanobacteria
- Be made available to the HABHRCA Interagency Task Force established by the Committee on the Environment and Natural Resources
- Prioritize research needed by OW to support risk assessment, regulatory determination, and guideline development
- Guide research by ORD and collaborators in academia
- Inform stakeholders.

RESULTS/CONCLUSIONS

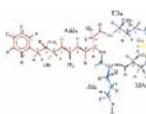
- IISOC products – a monograph including a synthesis paper on potential National Research Program components, 6 workgroup reports, 26 subtopic articles and multiple poster abstracts
- Analytical method for monitoring to collect occurrence data under the UCMR
- Effects data for risk assessment
- Prevention, control and mitigation methods



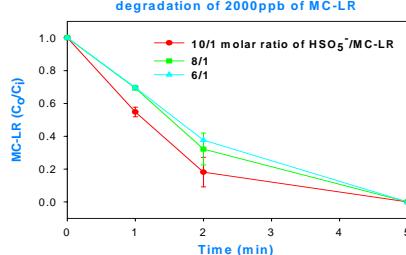
Saxitoxin toxin



Nodularin toxin



Effect of Oxone's Concentration on the degradation of 2000ppb of MC-LR



Microcystin-LR cyanotoxin (MC-LR) was degraded via in situ generation of sulfate radicals. Cobalt catalyzes the decomposition of peroxomonosulfate (PMS) to generate sulfate radicals which are very efficient in degrading MC-LRs as high as 2000 ppb in short period of time. This method can be applied in the treatment of unexpected events (i.e., eutrophication of lakes or terrorist action).

FUTURE DIRECTIONS

- Collaborate with other Federal organizations to design and implement a National Research Program on cyanobacterial HABs
- Inform upper management concerning the need for an integrated ORD research program on cyanobacteria
- Develop risk assessments for cyanobacteria and their toxins
- Develop regulations or guidelines for drinking water and recreational water

This poster does not necessarily reflect US EPA policy. Mention of trade names or commercial products does not constitute endorsement.



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